CLAIMS

1. A porous carbon substrate comprising a sheet which includes short carbon fibers dispersed in random directions and a carbonized resin, wherein in the sheet, the short carbon fibers are bound by the carbonized resin and the sheet has pores and wherein the volume of pores having pore sizes of 10 μm and less among the pores, per unit weight of the sheet is in the range of 0.05 to 0.16 cc/g.

2. A porous carbon substrate, according to claim 1, wherein the thickness of the porous carbon substrate is in the range of 0.10 to 0.25 mm.

3. A porous carbon substrate, according to claim 1, wherein the porosity of the porous carbon substrate is in the range of 70 to 90%

4. A porous carbon substrate, according to claim 1, wherein the average fiber diameter of the short carbon fibers is in the range of 5 to 20 μm.

5. A porous carbon substrate, according to claim 1, which contains a carbonaceous powder.

6. A porous carbon substrate, according to claim 1, wherein the maximum bending load of the porous carbon substrate, measured by a three-point bending test, is in the range of 0.25 to 2.0 N/cm.

7. A porous carbon substrate, according to claim 1, wherein the maximum bending load displacement of the porous carbon substrate, measured by a three-point bending test, is in the range

of 0.7 to 2.3 mm.

8. A porous carbon substrate, according to claim 1, wherein the bending modulus of elasticity of the porous carbon substrate, measured by a three-point bending test, is in the range of 1 to 15 GPa.

9. A porous carbon substrate, according to claim 5, wherein the particle diameter of the carbonaceous powder is in the range of 0.01 to 10 μm.

10. A porous carbon substrate, according to claim 5, wherein the carbonaceous powder is a powder of graphite or carbon black.

11. A porous carbon substrate, according to claim 5, wherein the amount of the carbonaceous powder is in the range of 1 to 60 wt%.

12. A porous carbon substrate, according to claim 1, wherein the average fiber length of the short carbon fibers is in the range of 3 to 20 mm.

13. A porous carbon substrate, according to claim 1, wherein the density of the porous carbon substrate is in the range of 0.3 to 0.7 g/cm^3.

14. A porous carbon substrate, according to claim 1, wherein the peak pore size of the pores in the porous carbon substrate is in the range of 25 to 55 μm.

15. A gas diffusion material comprising the porous carbon substrate as set forth in any one of claims 1 through 14 and a water repellent material added to the substrate.

16. A gas diffusion material comprising a conductive gas

diffusion layer formed at least on one side of the porous carbon substrate as set forth in any one of claims 1 through 14.

17. A gas diffusion material comprising a conductive gas diffusion layer formed at least on one side of the gas diffusion material as set forth in claim 15.

18. A membrane-electrode assembly comprising a solid polymeric electrolyte membrane, catalyst layers containing catalyst-loaded carbon provided on both the surfaces of the membrane, and gas diffusion materials provided in contact with both the catalyst layers, characterized in that at least one of the gas diffusion materials is the gas diffusion material as set forth in any one of claims 15 through 17.

19. A fuel cell, the membrane-electrode assembly of which is the membrane-electrode assembly as set forth in claim 18.

20. A process for producing the porous carbon substrate as set forth in claim 1, comprising a compression step for treating a fiber sheet precursor comprising short carbon fibers and a resin for compressing it and a carbonization step for treating the resin of the compressed fiber sheet precursor for carbonizing it, characterized in that in the compression step, the fiber sheet precursor is intermittently carried and passed between hot plates positioned in parallel to each other, and heated and pressed by the hot plates while they are stopped, then being carried again after completion of heating and pressing, to repeat the carrying and stopping alternately.

21. A process for producing a porous carbon substrate,

according to claim 20, wherein the fiber sheet precursor contains a carbonaceous powder.

22. A process for producing a porous carbon substrate, according to claim 20, wherein the resin is a thermosetting resin.

23. A process for producing a porous carbon substrate, according to claim 20, wherein the fiber sheet precursor contains a carbonaceous powder and the resin is a thermosetting resin.

24. A process for producing a porous carbon substrate, according to claim 22, wherein a post-curing step for post-curing the thermosetting resin is provided between the compression step and the carbonization step.

25. A process for producing a porous carbon substrate, according to claim 23, wherein a post-curing step for post-curing the thermosetting resin is provided between the compression step and the carbonization step.

26. A process for producing the porous carbon substrate as set forth in claim 1, comprising a compression step for treating a fiber sheet precursor comprising short carbon fibers and a resin for compressing it and a carbonization step for treating the resin of the compressed fiber sheet precursor for carbonizing it, characterized in that the fiber sheet precursor contains a carbonaceous powder.

27. A process for producing a porous carbon substrate, according to claim 26, wherein the resin is a thermosetting resin.

28. A process for producing a porous carbon substrate, according to claim 27, wherein a post-curing step for post-curing

the thermosetting resin is provided between the compression step and the carbonization step.

29. A process for producing the porous carbon substrate as set forth in claim 1, comprising a compression step for treating a fiber sheet precursor comprising short carbon fibers and a resin for compressing it and a carbonization step for treating the resin of the compressed fiber sheet precursor for carbonizing it, characterized in that the resin is a thermosetting resin.

30. A process for producing a porous carbon substrate, according to claim 29, wherein a post-curing step for post-curing the thermosetting resin is provided between the compression step and the carbonization step.

31. A process for producing a porous carbon substrate, according to claim 20, 26 or 29, wherein the fiber sheet precursor is continuously carried in the carbonization step.

32. A process for producing a porous carbon substrate, according to claim 20, wherein the value of LF/LP is from 0.1 to 0.98, where LP is the effective pressing length of the hot plates in the carrying direction and LF is the feed distance of the fiber sheet precursor when the precursor is carried intermittently.

33. A process for producing a porous carbon substrate, according to claim 20, wherein the temperature of the hot plates is from 140 to 300°C and the pressing pressure of the hot plates is from 0.1 to 40 MPa.

34. A process for producing a porous carbon substrate, according to claim 20, 26 or 29, wherein the fiber sheet precursor

is paper in which the short carbon fibers are bound by a binder.

35. A process for producing a porous carbon substrate, according to claim 23, wherein the amount of the thermosetting resin is from 20 to 300 parts by weight while the amount of the carbonaceous powder is from 1 to 200 parts by weight per 100 parts by weight of the short carbon fibers of the fiber sheet precursor.

36. A process for producing a porous carbon substrate, according to claim 27, wherein the amount of the thermosetting resin is from 20 to 300 parts by weight while the amount of the carbonaceous powder is from 1 to 200 parts by weight per 100 parts by weight of the short carbon fibers of the fiber sheet precursor.

37. A process for producing a porous carbon substrate, according to claim 35 or 36, wherein the fiber sheet precursor is heated at a heating rate of 10 to 1,000°C/min up to at least a temperature of 1,200°C, for carbonizing the thermosetting resin.

38. A process for producing a porous carbon substrate, according to claim 21, 23 or 26, wherein the particle diameter of the carbonaceous powder is from 0.01 to 10 μm.

39. A process for producing a porous carbon substrate, according to claim 21, 23 or 26, wherein the carbonaceous powder is a powder of graphite or carbon black.

40. A process for producing a porous carbon substrate, according to claim 20, 26 or 29, wherein the average fiber diameter of the short carbon fibers is from 5 to 20 μm.

41. A process for producing a porous carbon substrate, according to claim 20, 26 or 29, wherein the average fiber length

of the short carbon fibers is from 3 to 20 mm.

42. A process for producing a porous carbon substrate, according to claim 22, 23, 27 or 29, wherein the thermosetting resin is a phenol resin.

43. A process for producing a porous carbon substrate, according to claim 42, wherein the phenol resin is a phenol resin synthesized without using a metal catalyst or an alkali catalyst.

44. A process for producing a porous carbon substrate, according to claim 22, 23, 27 or 29, wherein the curing degree of the thermosetting resin is 70% or more.

45. A process for producing a porous carbon substrate, according to claim 24, 25, 28 or 30, wherein the heating temperature of the fiber sheet precursor in the post-curing step is from 140 to 300°C.

46. A process for producing a porous carbon substrate, according to claim 25, wherein the fiber sheet precursor has the thermosetting resin carbonized by heating at a heating rate of 500 to 10,000°C/min up to at least 1,200°C.

47. A process for producing a porous carbon substrate, according to claim 28, wherein the fiber sheet precursor has the thermosetting resin carbonized by heating at a heating rate of 500 to 10,000°C/min up to at least 1,200°C.

48. A process for producing a porous carbon substrate, according to claim 20, 26 or 29, wherein the highest temperature of the heating temperature in the carbonization step is from 1,200 to 2,500°C.